



Comparison of pain threshold and duration of pain perception in men and women of different ages

Comparação do limiar de dor e tempo de percepção de dor em homens e mulheres de diferentes faixas etárias

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Abstract

Introduction: Pain is a sensory and emotional experience that occurs with the presence of tissue injury, actual or potential. Pain is subjective, and its expression is primarily determined by the perceived intensity of the painful sensation, called the pain threshold. **Objective:** To evaluate whether there are differences in pain threshold (LD) and time to pain perception (TPED) between the gender in different age groups and to analyze the correlation between age and pain threshold in each gender. **Methods and procedures:** Participants were 60 volunteers divided into 6 groups (n = 10 each) according to gender and age (18–33, 34–49, and 50–64 years). The evaluation of perception and pain tolerance was performed by immersing the container with one hand in water at a temperature of 0 °C–2 °C; the latency to withdrawal of the hand from ice water was measured in seconds and was considered a measure of LD. The TPED was reported by each participant as the start time of the painful stimulus. **Results:** We found differences between the LD for G1 (men aged between 18 and 33 years) and G2 (women aged 18 to 33 years) with greater LD for G1 (p = 0.0122) and greater LD for women (p = 0.0094); for other comparisons of LD and TPED, there were

no differences ($p > 0.05$ for all comparisons). Low correlation was found between age progression with increased LD and the TPED only in men ($p = 0.01$ and $r = 0.45$ and $p = 0.05$ and $r = 0.34$, respectively). **Conclusion:** We conclude that women have a higher pain threshold than men especially when these groups are aged between 18 and 33 years, and in men increasing age correlates with increased TPED and LD.

Keywords: Pain. Pain threshold. Pain perception.

Resumo

Introdução: A dor é uma experiência sensorial e emocional que aparece com a presença de lesões teciduais, reais ou potenciais. A dor tem caráter subjetivo e sua exteriorização é determinada, principalmente, pela intensidade percebida da sensação dolorosa, chamada limiar de dor. **Objetivo:** Avaliar se há diferença no limiar de dor (LM) e no tempo de percepção a dor (TPED) entre os sexos em diferentes faixas etárias, e analisar se há correlação entre faixa etária e limiar de dor em cada sexo. **Métodos e procedimentos:** Fizeram parte do estudo 60 voluntários, divididos em 6 grupos ($n = 10$ cada) de acordo com o sexo e faixa etária (18 a 33, 34 a 49 e 50 a 64 anos). A avaliação da percepção e tolerância à dor foi realizada pela imersão da mão em um recipiente com água na temperatura de $0\text{ }^{\circ}\text{C}$ - $2\text{ }^{\circ}\text{C}$, a latência para retirada da mão da água gelada foi medida em segundos e considerada como medida do LD, o TPED foi relatado por cada participante como o instante de início do estímulo doloroso. **Resultados:** Foram observadas diferenças entre o LD para os grupos G1 (homens com idade entre 18 e 33 anos) e G2 (mulheres com idade entre 18 e 33 anos), com maior LD para o G1 ($p = 0,0122$); e entre os sexos, maior LD para mulheres ($p=0,0094$), para as demais comparações do LD e do TPED não houve diferenças ($> 0,05$ para todas as comparações). Foi encontrada baixa correlação entre progressão da idade com aumento do LD; quanto ao TPED, tal correlação foi detectada apenas nos homens (respectivamente $p = 0,01$ e $r = 0,45$; e $p = 0,05$ e $r = 0,34$). **Conclusão:** Concluímos que as mulheres apresentam maior limiar doloroso que os homens, principalmente quando estes grupos estão com idade entre 18 e 33 anos; e que nos homens o aumento da idade se correlaciona tanto com o aumento do TPED quanto do LD.

Palavras-chave: Dor. Limiar da dor. Percepção da dor.

Introduction

Pain is a multi-factorial phenomenon influenced by tissue injury and emotional, socio-cultural, and environmental aspects and is conceptualized as “an unpleasant sensory and emotional experience that is described in terms of actual or potential tissue injuries” (1). It has subjective characteristics, and each individual learns and uses this term based on their previous experiences (2). We consider this sensation to be a protective mechanism of the body against tissue damage, acting as a psychological adjunct to a protective reflex that causes the affected tissue to diverge from harmful and/or noxious stimuli.

Pain is part of everyday life for most people and is closely related to individuals' quality of life (3). It is one of the symptoms that most often leads individuals to seek professional care in health services (4). It can lead to other health problems, such as eating

disorders, sleep irregularities, and systemic bodily fatigue (5, 6). In recent decades, the incidence has been increasing, probably due to changes in lifestyle, increased survival of severely ill patients, and increased life expectancy (7).

Intense stimuli, whether thermal, mechanical, or chemical, can activate nociceptors. When tissue is injured or irritated, chemical substances (histamine, prostaglandins, bradykinin) are released, causing the activation of pain receptors and making the tissue hypersensitive; thus, after the initial insult, the tissue will become irritable and sensitive (8).

There are several studies that examine differences between men and women in the perception and tolerance of pain. However, the results are controversial and find no consensus as to which gender is more sensitive to pain. According to some authors, women experience more frequent conditions of pain, a better ability to describe pain, a lower sensory threshold,

less tolerance to pain, and a more unpleasant sensation (8, 9, 10, 11, 12). On the other hand, for Budó and colleagues (4), women support more pain than men, because they live with menstrual cramps and go through the pain of childbirth.

Another factor that should be taken into account when analyzing the perception of pain is age. Studies with the young and the old, attempting to assess the sensitivity to and tolerance of pain, demonstrate that there may be differences in pain sensitivity between age groups (12, 13, 14)

In order to assist in obtaining parameters on pain, this study aims to investigate differences in pain threshold between the genders in different age groups and to analyze whether there is a correlation between age and pain threshold.

Methods and procedures

Experimental design and ethical aspects

The study is characterized as longitudinal, experimental consecutive sampling. All subjects agreed to participate by signing the Informed Consent Form, in accordance with the provisions of Resolution 196/96. The development of the research was approved by the Ethics Committee in Research of the Faculty of Philosophy and Sciences at Marília - Unesp, protocol nº 1866/2010.

Subjects

A total of 60 volunteers took part in the study, 30 female and 30 male residents from the city of Marília, SP, Brazil. The volunteers were divided, according to gender and age group, into six groups of 10 subjects each: Group 1 (G1), composed of female volunteers aged 18–33 years; Group 2 (G2), consisting of male volunteers aged 18–33 years; Group 3 (G3), composed of female volunteers aged 34–49 years; Group 4 (G4), consisting of male volunteers aged 34–49 years; Group 5 (G5), composed of female volunteers aged 50–64 years; and Group 6 (G6), consisting of male volunteers aged 50–64 years. The presence of peripheral neuropathy or previous surgery on the dominant hand, cardiac or neuromuscular disorders, or premenstrual period or catamenial flow were used as exclusion criteria (15).

Procedures

The volunteers were properly accommodated in an acclimatized room in a comfortable posture and free of any situation that could cause distraction and thus interfere with the results of the experiment. They were measured for their weight and height using an anthropometric scale (JB Scales®, from São Paulo, SP, Brazil) for subsequent calculation of Body Mass Index (BMI). All underwent 15 minutes of habituation to the environment in which the experiments were conducted.

Initially, the volunteers immersed the dominant hand in a container with warm water at 37 °C for a period of five minutes (16). Temperature control was achieved by means of a water boiler (Western®, from São Paulo, SP, Brazil) and verified using a mercury thermometer (WalMur®, from Porto Alegre, RS, Brazil). After removing the hand from the warm water, it was immediately immersed in a container with ice-cold water at 0 °C–2 °C (15, 17). Temperature control was maintained by adding ice cubes and monitored by means of a mercury thermometer (WalMur®), thereby ensuring the maintenance of the stimulus at the originally determined temperature. Volunteers remained with their hands immersed until the discomfort caused by the low temperature reached a maximum subjective intensity, forcing them to withdraw their hands. The permanence time in the ice-cold water was measured using a stopwatch. The time until the verbal report of pain was taken as the time of perception to painful stimuli (TPED), and the time between immersion and withdrawal of the limb was considered the pain threshold (LD).

Statistical analysis

For data analysis, the Shapiro-Wilk normality test and Levene's test were used to check the homogeneity of variance. Then, the Kruskal-Wallis test was applied followed by the multiple comparisons Student-Newman-Keuls test. For correlation analysis, the Spearman correlation test was used. The magnitude of the correlations was established at: low, from 0.26 to 0.49; moderate, from 0.50 to 0.69; high, from 0.70 to 0.89; and very high, from 0.90 to 1.00. The level of significance was set at 5% ($p \leq 0.05$).

Results

Groups as well as individuals in their totality, divided between male participants and female participants, were shown to be homogeneous in age and BMI. During the comparison between groups of the same age, statistically significant differences were only evident for LD between G1 and G2 ($p = 0.0122$); for other comparisons, G3 with G4 ($p = 0.0695$) and G5 with G6 ($p = 0.8203$), there were no significant differences. For comparisons between different age groups, we observed significant differences between G2 vs. G3 ($p = 0.0065$), G2 vs. G5 ($p = 0.0190$), and G2 vs. G6 ($p = 0.0283$); for the other comparisons, no statistically significant differences were observed (G1 vs. G3 [$p = 0.4720$], G1 vs. G4 [$p = 0.1847$], G1 vs. G5 [$p = 0.6761$], G1 vs. G6 [$p = 1$], G2 vs. G4 [$p = 0.2261$], G3 vs. G5 [$p = 1$], G3 vs. G6 [$p = 0.4717$], G4 vs. G5 [$p = 0.1852$] and G4 vs. G6 [$p = 0.2897$]).

The comparison between groups of the same age for the TPED showed no statistically significant differences for G1 vs. G2 ($p = 0.4214$), G3 vs. G4 ($p =$

0.4932), and G5 vs. G6 ($p = 0.6197$). For comparisons between different age groups, we observed significant differences between G2 vs. G4 ($p = 0.0292$) and G2 vs. G6 ($p = 0.0468$); for the other comparisons, no statistically significant differences were observed (G1 vs. G3 [$p = 0.4919$], G1 vs. G4 [$p = 0.1807$], G1 vs. G5 [$p = 0.1488$], G1 vs. G6 [$p = 0.2883$], G2 vs. G3 [$p = 0.1817$], G2 vs. G5 [$p = 0.202$], G3 vs. G5 [$p = 0.5941$], G3 vs. G6 [$p = 0.7030$], G4 vs. G5 [$p = 0.8491$], and G4 vs. G6 [$p = 0.5169$]). Table 1 shows the characteristics of the sample regarding gender, age, LD, TPED, and BMI within the groups assessed.

Table 2 details the characteristics of participants grouped according to gender. We observed differences between men and women only for LD ($p = 0.0094$); differences between the genders were not observed for TPED ($p = 0.8118$).

Table 3 shows the correlations between the total scores of LD, TPED, and age.

Table 4 describes the correlations between the representative scores of the gender-related characteristics of the participants.

Table 1 - Characterization of the subjects studied

Groups	Age (years)	LD (s)	Min-Max LD (s)	TPED (s)	Min-Max TPED (s)	BMI (Kg/(m) ²)
G1	24.7 ± 4.50	53.6 ± 14.12*	40-85	16.3 ± 5.83	10-25	23.47 ± 2.01
G2	23.7 ± 3.30	37.6 ± 11.79	20-60	13.7 ± 4.62	5-20	23.41 ± 1.80
G3	37.4 ± 4.93	57.6 ± 15.56	35-93	18.8 ± 7.64	10-30	25.78 ± 0.52
G4	40.4 ± 6.00	47.2 ± 17.32	30-90	21.8 ± 8.45	10-35	26.08 ± 1.01
G5	56.8 ± 4.42	57.6 ± 18.35	34-90	20.3 ± 6.03	10-30	25.63 ± 0.48
G6	57.0 ± 3.65	54.7 ± 18.27	32-89	19.3 ± 6.03	15-32	26.54 ± 0.54

Note: LD: Pain threshold; TPED: Time to perception of painful stimuli; Min: minimum; Max: maximum; BMI: Body mass index; s: seconds; Kg/(m)²: kilos/(meters)²; *: Statistically significant difference between G1 and G2.

Source: Research data.

Table 2 - Representation of the subjects divided according to gender

Groups	Age (years)	LD (s)	Min-Max (s)	TPED (s)	Min-Max (s)	BMI (Kg/(m) ²)	Min-Max
Men	40.36 ± 14.48	46.5 ± 17.04*	20-90	18.26 ± 7.21	5-35	25.34 ± 1.84	21.04-27.88
Women	39.63 ± 14.15	56.26 ± 15.66	34-93	18.46 ± 6.54	10-30	24.96 ± 1.59	20.11-26.24

Note: LD: Pain threshold; TPED: Time to perception of painful stimuli; Min: minimum; Max: maximum; BMI: Body mass index; s: seconds; Kg/(m)²: kilos/(meters)²; *: Statistically significant difference between the genders.

Source: Research data.

Table 3 - Correlations between LD, TPED, and age

Correlation	p	r
TPEDt vs. AGEt	$p < 0.01^*$	0.3397
TPEDt vs. LDt	$p < 0.0001^*$	0.5519
LDt vs. AGEt	0.10	0.2119

Note: LDt: Total pain threshold; TPEDt: Total time to perception of painful stimuli; AGEt: Total age; *: Statistically significant value.
Source: Research data.

Table 4 - Correlations between characteristics referring to the gender of the participants

Correlation	p	r
LDm vs. TPEDm	$p < 0.0001^*$	0.6754
TPEDm vs. AGEm	0.05*	0.3493
LDm vs. AGEm	0.01*	0.4569
LDf vs. TPEDf	$p < 0.01^*$	0.5004
TPEDf vs. AGEf	0.09	0.3123
TPEDf vs. AGEf	0.82	0.0417

Note: LDm: Male pain threshold; TPEDm: Total time of male perception to painful stimuli; AGEm: Male age; LDf: Female pain threshold; TPEDf: Total time of female perception to painful stimuli; AGEf: female age; *: Statistically significant value.
Source: Research data.

Discussion

The aim of our study was to analyze differences in the pain threshold between the genders in different age groups and to analyze whether there is a correlation between the age group with the pain threshold of men and women. These aspects related to pain modulation in accordance with gender and age should be taken into consideration to tailor treatments and medications to the specifications of each patient. Research on the differences based on the experience of pain between the genders could allow the adaptation of the treatment for pain to the characteristics of the individuals (18). Our methodology combines knowledge, as it proposes to seek under-explored differences in literature regarding LD, TPED, and their modulation by both age and gender.

In this study, we evaluated the sensitivity of LD and TPED for the dominant upper extremity immersed in water at approximately zero degrees, reproducing an acute nociceptive pain characteristic (19). LD was regarded as the greatest intensity of time in which

the stimulus is perceived as being uncomfortable to the point of the individual retracting his or her hand and/or requesting discontinuation, and TPED was considered the first report of pain after immersion.

The discrimination of different degrees of temperature is perceived by thermoreceptors located on the surface of the skin as well as free nerve endings. The cold receptors are linked to medium-diameter myelinated fibers in group A δ , although there are some fibers attached to small calibrated non-myelinated fibers in group C. Nerve fibers react differently to each thermal stimulus. When the temperature is very low, close to 0 °C, only cold-pain fibers are stimulated; it is reported that, when immersing a region in cold water, the first perceived sensation is the cold, replaced in up to one minute by a deep sense of pain and discomfort, triggering sensations of pricking, stinging and tingling, intensity, and gradual decline of one to three minutes when anesthesia of the region occurs (feeling of numbness), i.e., partial loss of thermal, tactile sensation among others. However, even after termination of the thermal stimulus, the sensations

of deep discomforting pain, throbbing, or burning are still perceived (20).

During our study protocol, the maximum time of 35 seconds for TPED was obtained by an individual from G4, and for LD 93 seconds was obtained by a subject from G3. However, in our experiment, a significant difference was found only among participants in G1 and G2 and when males and females were separated for LD. As for the TPED, no significant differences were observed. The results observed between males and females differ from those of other studies in which the authors indicate that female patients were more prone to complaints of pain, explaining such an assertion with the greatest variety of painful conditions assigned to women, such as migraines, temporomandibular disorders, fibromyalgia complaints, pregnancy, and childbirth, besides having more severe levels of pain with more frequent episodes and of a longer duration than men (21, 22, 23, 24).

It is noteworthy that the differences in the sensation of pain between genders can vary greatly across studies because of the different methods used for its measurement as well as the body area stimulated and the number of repetitions used during the experiment (18). Other factors that are difficult to control and can influence the results are the psychological characteristics of each participant; different levels of anxiety, depression, or previous painful experiences of each subject can alter the reports of pain (25, 26, 27).

Correlation analysis between TPEDt and AGEt identifies an increase in the time of pain perception with increasing age. Andrade and colleagues (14, 28) found that advanced age results in loss of pain perception; among the physiological factors pointed out, it is believed that the degree of conservation of the peripheral nervous system is lower in older people, which predisposes damages in the afferents related to pain perception.

The moderate correlation directly proportional between TPEDt and LDt indicates the longer the perception of painful stimuli, the more the pain threshold will be. However, LDt is not related to AGEt. Based on these results, we hypothesized that the modulation of pain sensation may occur on an organization of levels where the stimuli are added, and, even though the pain perception is initially reduced due

to advanced age, the summation of stimuli occurring triggers protective responses based on individual previous experiences.

When we analyzed these responses and related them to the participants' gender, we realized that LD continues to correlate with TPED in both men and women. Nevertheless, differing from the overall results, the age in males plays a relevant role in modulating both TPED and LD, whereas women's age is not correlated with TPED or LD. Even though there is no consensus regarding the modulation of the menstrual cycle phase on pain sensitivity, a likely explanation is that female hormonal changes predispose women to episodes of pain with characteristics from the menstrual cycle phase, regardless of age (8, 29, 30).

The continuity of research that relates pain to gender should encompass different age groups, including subjects under 18 years of age and those over 60 years of age. Another point that should be taken into consideration is the menstrual cycle to better understand the relationship between hormonal variation and threshold of pain.

Conclusion

We conclude that, for the experimental condition proposed, women have a higher pain threshold than men, especially when these groups are aged between 18 and 33 years. We also conclude that, in men, increased age correlates well with the increase of TPED and LD. However, in women, age group is not related to TPED or LD. There may be other factors related to the perception of pain, for example, hormonal changes due to the menstrual cycle phase.

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Received: 05/21/2013

Recebido: 21/05/2013

Approved: 12/07/2013

Aprovado: 07/12/2013